RESEARCH OF STUDY SUBJECTS' INTERCONNECTION FOR TRANSPORT AND LOGISTICS EDUCATIONAL PROGRAMS

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The purpose of the paper is to present the methodology and its implementation results in the field of statistical research of TTI study process trends by use of analytical system.

The actual analytical system (AS TTI) for data maintenance and analysis was created at Transport and Telecommunication Institute (TTI) based on the OLAP principle [1]. The paper represents experimental results of the analytical system implementation for statistical research of study subjects' interconnections for transport and logistics educational programs.

Advanced technology allows users to perform a multidimensional data analysis for decision making purposes. The system uses independent Data Marts, which are constructed basing on information delivered from actual TTI Information System (OLTP).

The paper emphasizes one of the analytical tasks of study processes management at the university, which has been solved using the AS TTI Data Mart "Analysis of examinations marks for study subjects at different study programs.

As the example of the suggested methodology some correlation coefficients were calculated and analyzed to characterize examination marks interdependency between study subjects for several educational programs in the transport and logistics area. As the result factually existing study subject interconnection was recognized on the base of correlation analyses. The analytical methodology implemented in the AS TTI was recommended as an eventual tool for investigation of study subjects' interconnection, aimed to improve the quality of educational programs.

Keywords*: the University Analitical System, OLAP-technology and Data Marts*

1. Introduction

The research in the field of education services quality control was launched at TTI in 1998 [1]. This work has been conducted within the frames of several projects orientated to the development of the Baltic Region [2].

The updated analytical system (AS TTI) for data maintenance and analysis was created on the OLAP principle. The paper represents the results of the AS TTI by research of TTI study process trends.

The technology used by AS TTI allows performing a multidimensional data analysis for decision making purposes. The system applies independent Data Marts, which were constructed by use of information from actual TTI Information System (OLTP) by data filtering and clearing from the whole period of its operation.

The OLAP-technologies would help to improve the currently used TTI decision support computer system making use of the existing information systems of the University.

Undertaken research and interrogation of top managers of the University have defined the following possible task of AS TTI: Analysis of examinations marks for study subjects at different study programs in the context of years of enrolment, faculties, study types and study languages.

2. TTI Information System Overview

The TTI information system (IS), based on OLTP technology is successfully supporting multiple information processes at the university. The system is aimed to registration of all aspects of the institute's study activity, as well as the management of its intellectual, material and financial resources. Integral part of the system is e-learning [3].

It therefore includes more than ten subsystems each directed to the solution of a certain class of tasks, described in [6].

Existing IS has been implemented by the employees of the Information Technologies Department of the university with the use of MySQL DB and WEB-server Apach.

Modern network technology application and common database, within the implementation of computer-aided information system of the university, permits to install a simple mechanism of information integration into common information resource and provide opportunity to share information with many users (university administration, students, lecturers etc.). Thus the higher level of data integrity may be achieved as well as conditions will appear to create successful functioning of common information environment of the university.

Access to time-schedule and other information required by a large number of users is achieved through WEB-interface for any user at any time and at any point (if the user has been properly authorized).

3. TTI Analytical System AS TTI

AS TTI architecture was created to support the following activities.

Initial data for analysis were selected from the existing IS, preliminary tested and filtered by some features. The data represent value of indices, which characterize study process at certain study program during the whole period of IS functioning.

Data were gathered and stored in the data warehouse created in accordance with the principles of database warehouses construction and representing the relation database organized in particular "Star" scheme. For the simplicity, it was decided to fix several data marts instead of one data warehouse, containing data of specific direction of analysis tasks.

The advantages of the suggested data storage model in the form of data warehouses are follows:

- data support historical demands, analysis of tendencies and strategic decision-making;
- the model is orientated to the subject area;
- common coordinated definition of data and mutual data domains at the enterprise level;
- controlled denormalization for the efficient data extraction;
- contains data with full or partial history of changes;
- contains temporal data;
- contains internal data of the enterprise, as well as useful external data helping to conduct analysis of tendencies, for example, demographic and economic data.

The main table of warehouse or mart (table of facts) contains numerical values of indices that serve for gathering information. Table of facts and tables of measurements are connected in accordance to the "Star" topology.

The "Star" topology has been chosen from two possible data warehouse topologies – "Star" and "Snowflake" – taking into account its simplicity and speed of operation.

The Star model of database has the following structure. The essential information on students' marks is assembled in the table of facts. The tables of measurements consist of more detailed information about study programs, periods of studying, types of program, study languages, study types, faculties, courses etc.

The replication of warehouse once per term is assumed, after the data about progress per term is entered in IS, and rates are verified and calculated.

User obtains opportunity of remote access to data stored in the system with the help of customer application and gets the opportunity to form requests, generate reports, and obtain arbitrary sub-sets of data for further analysis.

In the considered Analytical System several Microsoft SQL Server 2005 applications were used:

- Database Engine for creating and storage of databases, construction of data warehouse (mart);
- Data Transformation Services for import of necessary part of data from OLTP-system;
- Analysis of Services for construction of OLAP-cube and OLAP-system building.

At the final step of analyses MS Excel application was used for data visualization and charts and graphs construction.

4. Suggested Methodology Description

Results of AS TTI implementation were based on our previous research, published in [6]. To perform the research new data marts and visualization were created and statistical data updated.

To verify application of the suggested method of analytical tasks solution by DSS with the use of new structure of the stored data, subject orientated marts of historical data (data marts) were created in connection with common organizational process.

Analysis of examinations marks for study subjects at different study programs in the context of years of enrolment, faculties, study types and study languages were considered as the research goal.

The following procedure for the mentioned analytical task solution was offered (see Fig.1):

Suggested methodology is based on a conclusion about apparent dependency between students' marks from different study subject. It is widely accepted by educators that there are study subject chains (sets of interrelated subjects), e.g. in mathematics or economics area. We allow existence of interrelation (correlation) between students' examination marks as well as between study subject content. For example, good students' knowledge (and marks) in "Higher Mathematics" leads to high marks (and good knowledge) in study subject "Optimization Theories and Methods".

On the base of this assumption a kind of experiment of students' marks correlation research was performed at transport and logistics educational programs. The research was supported by existing statistical tools build in MS SQL Server 2005 Analysis Services.

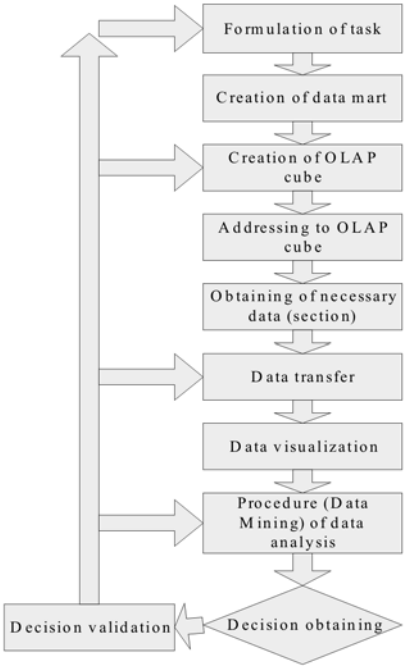

Fig. 1. The offered procedure for analytical task

5. The Example of Analysis

Required information was collected for two programs from the field of transport and economics thought at TTI during 2005-2008.

The first program is "Bachelor of Social Sciences in Management Science", the second one "Transport Management" professional study program.

Data Mart was build on the data from IS TTI for following dimensions: program type, instruction language, enrollment year and educational program type (full-time, part-time).

An attempt was made to find a correlation between students' marks for couples of study subjects from a common area. For example, "Higher Mathematics" and "Optimization Theories and Methods" or "Statistics" and "Optimization Theories and Methods", "Optimization Theories and Methods" and Bachelor or Diploma theses defense.

As the results of this research a kind of a weak correlation was determined. Calculated correlations coefficients were in the range from 0.5 to 0.55. For a human related statistics the correlation coefficient higher than 0.5 may be considered as meaningful because of strong influence of human behavior.

The following Figures 2, 3 present a scatterplot and chart of marks for two couples of study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" for Bachelor of Social Sciences in Management Science education program for 2005 year of enrollment (full-time).

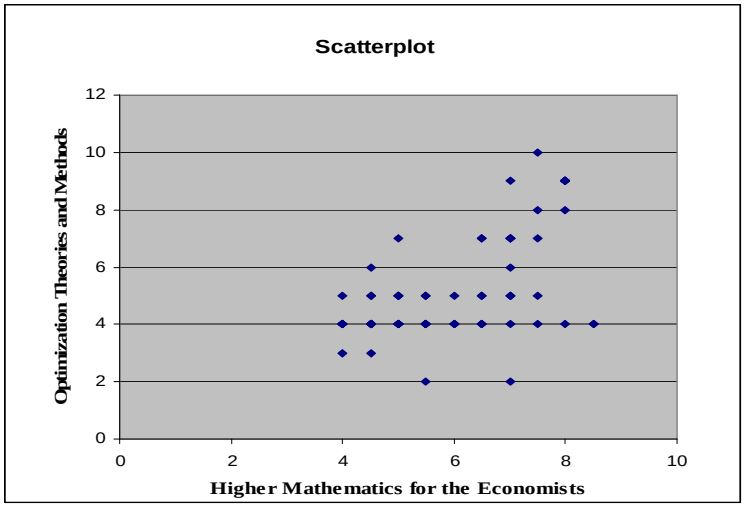

Fig. 2. The scatterplot of marks for two study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

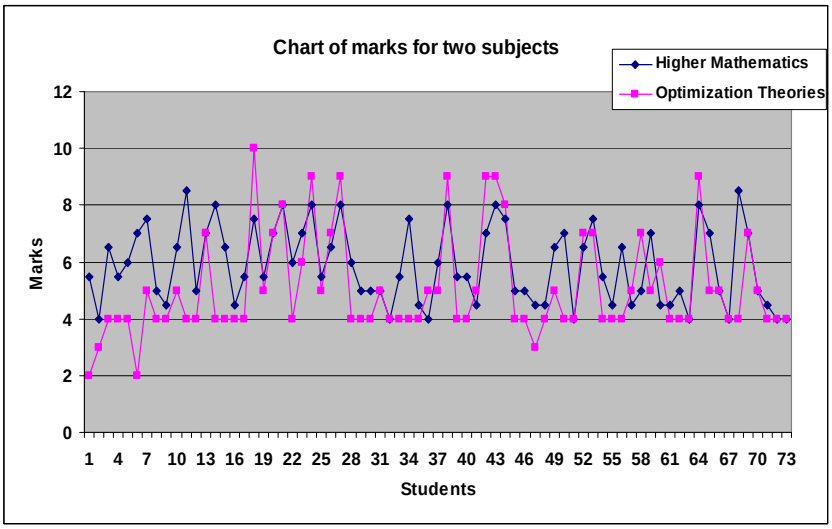

Fig. 3. The chart of marks for two study subjects "Higher Mathematics for the Economists" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

The following Figures 4, 5 present a scatterplot and chart of marks for two couples of study subjects "Statistics for the Economists" and "Optimization Theories and Methods" for Bachelor of Social Sciences in Management Science education program for 2005 year of enrollment (full-time).

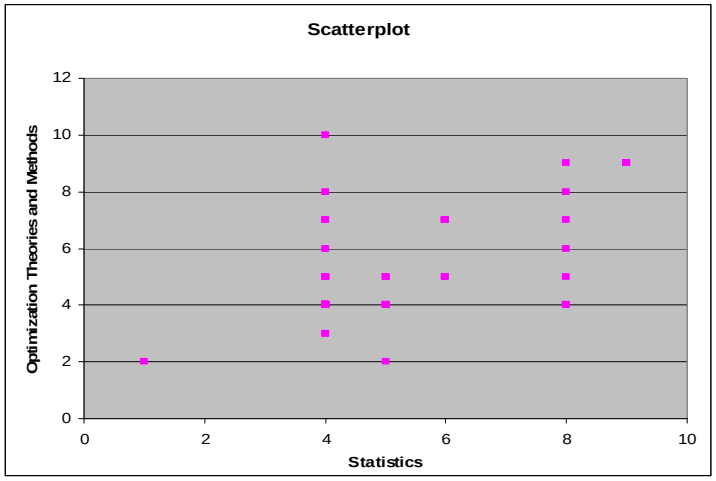

Fig. 4. The scatterplot of marks for two study subjects "Statistics" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

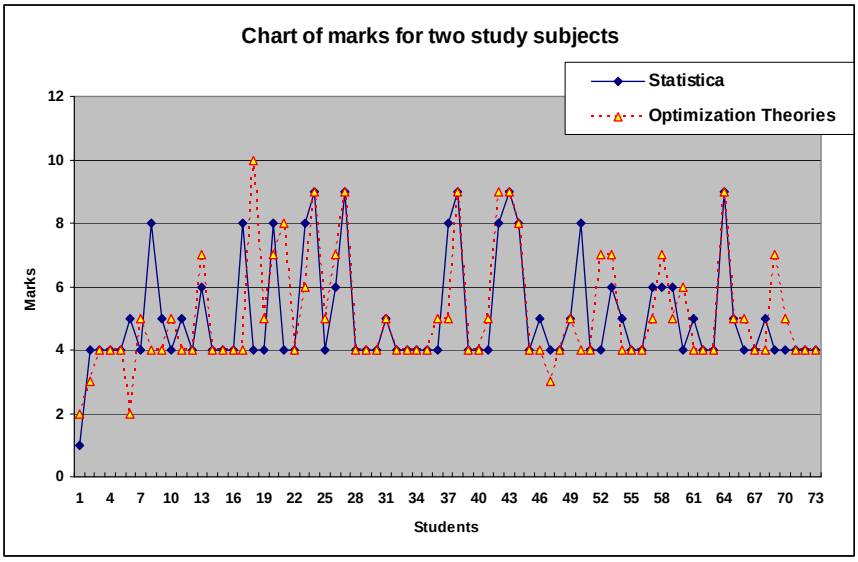

Fig. 5. The chart of marks for two study subjects "Statistics" and "Optimization Theories and Methods" ("Bachelor of Social Sciences in Management Science" education program)

The following Figures 6,7 present a scatterplot and chart of marks for two couples of study subjects "Higher Mathematics" and "Optimization Theories and Methods" for "Transport Management" Professional study program for 2006 year of enrollment (full-time).

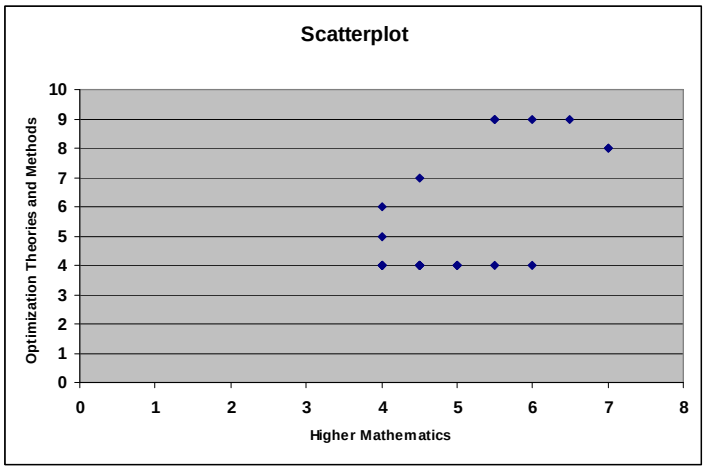

Fig. 6. The scatterplot of marks for two study subjects "Higher Mathematics" and "Optimization Theories and Methods" ("Transport Management" professional study program)

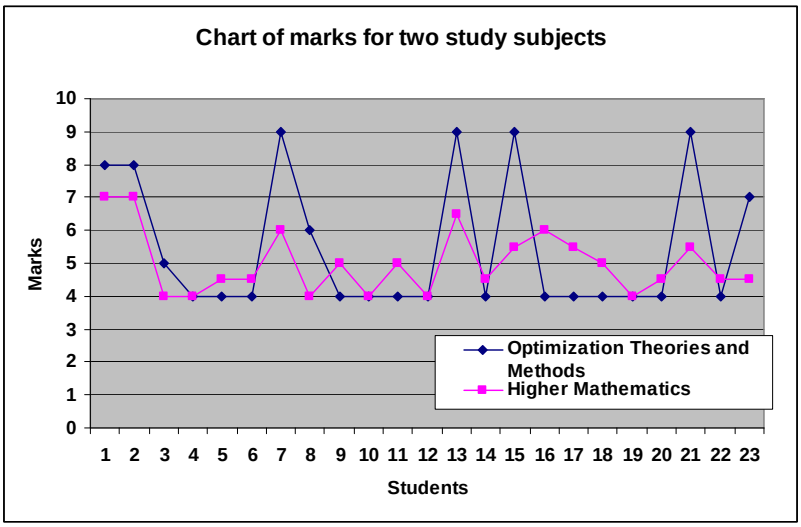

Fig. 7. The chart of marks for two study subjects "Higher Mathematics" and "Optimization Theories and Methods". Transport Management professional study program

The following Figures 8,9 present a scatterplot and chart of marks for two couples of study subjects "Statistics" and "Optimization Theories and Methods" for "Transport Management" professional study program for 2006 year of enrollment (full-time).

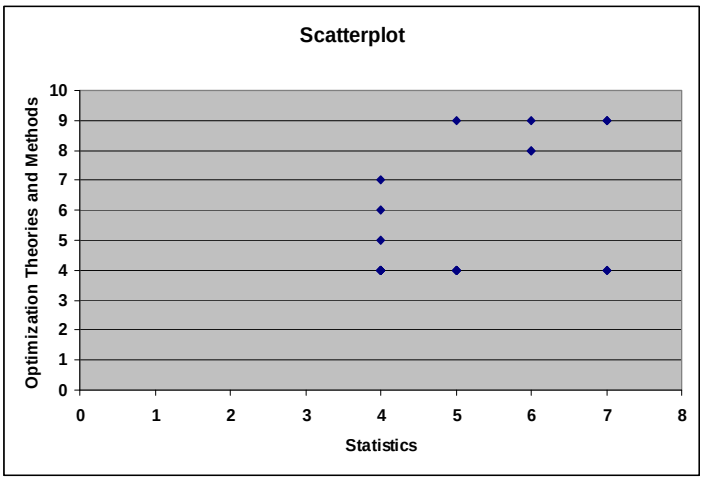

Fig. 8. The scatterplot of marks for for two study subjects "Statistics" and "Optimization Theories and Methods". Transport Management professional study program

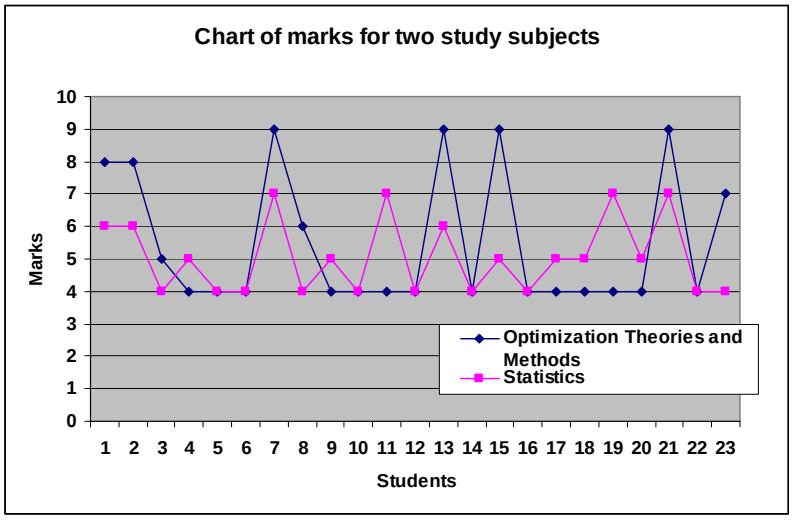

Fig. 9. The chart of marks for two study subjects "Statistics" and "Optimization Theories and Methods". Transport Management professional study program

Unfortunately, our research didn't give us evidences about correlation between any particular study subjects and Bachelor and Diploma Theses defense. The fact may be explained by multidisciplinary nature of Bachelor and Diploma theses, which hide the existing correlation.

Conclusion

As a result of this research it is possible to conclude the following:

1. Discussed AS TTI gives a real opportunity for study process trends research.
2. Received results can be successfully used in study process improvements.

The suggested research methodology may be used for decision support system's design by other Universities.

The considered approach and experimental implementation of OLAP system (AS TTI) may be recommended as a tool for dependences investigation between learning outcome and student marks from different subjects.

This information allows solving following practical tasks:

1. Verification of actual study subjects' interconnection, which are declared in study plans.
2. Quantitative measurement of study content improvement results from the learning outcome point of view.

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